Soft phonation index – a sensitive parameter?

Mili Mary Mathew · Jayashree S. Bhat

Abstract

Objective The diagnosis of voice disorders is based on perceptual and acoustic paradigms. Modern acoustic analysis systems are relatively inexpensive and user friendly. One aspect of laryngeal function that is of great interest is the extent of vocal fold closure. Soft phonation index (SPI) is the parameter in Multi Dimensional Voice Program, which reflects the approximation of vocal folds. High values of SPI are stated to correlate with incomplete vocal fold adduction and are a better indicator of breathiness than EGG.

This study aims to determine the sensitivity of this acoustic parameter of SPI, as a reflective indicator of incomplete vocal fold adduction in male patients diagnosed with unilateral vocal nodules.

Methodology 60 participants were included in the study; 30 with normal vocal fold functioning in the control group and 30 with unilateral vocal nodules in the experimental group. The phonation sample of vowel /a/ was recorded into CSL 4150 of Kay Elemetrics, in a sound treated room. The readings of SPI on the MDVP analysis was extracted and subjected to statistical analysis using independent samples ‘t-test’ using SPSS Version 11.

Results The results of the study reveal that there was a statistically significant difference between the means of the SPI values between the control and the experimental groups.

Discussion It can be understood that SPI is a sensitive parameter to detect abnormalities in vocal fold approximation in the considered population of individuals with vocal nodules. This is in coherence with a study done on patients with vocal fold palsy and cordectomy, wherein SPI was found to be a good indicator of breathiness. The SPI mean obtained for participants in the control group was higher than the Western normative mean specified in MDVP, which highlights the importance of establishing normative values for Indian population.

Conclusion It can be concluded that SPI was sensitive to detect changes affecting vocal fold closure in unilateral vocal nodules. But this conclusion has to be generalized with caution keeping in mind that only one population with vocal pathology was studied. The factors of vocal fold physiology and mechanical properties of vocal tract, which may contribute to individual variations in SPI values, have to be considered for further research.

Keywords Voice disorders · Objective assessment · SPI

Introduction

Voice is the sound produced by the vibration of vocal folds [1]. This sound is shaped by the vocal tract into a unique acoustic form with the modulations occurring at the respiratory, phonatory, articulatory and resonatory levels. Normal voice is characterized by adequate loudness, hygienic production, pleasant quality, flexibility and representativeness to the speaker. These five aspects can be affected in varying degrees in the case of any vocal pathology, resulting in deviant voice characteristics.

The diagnosis of a voice disorder is usually based on perceptual and acoustic paradigms, which in turn help to make an analysis of the patient behaviours relative to the integrity of the mechanisms of respiration, phonation and resonance.

M. M. Mathew (✉) · J. S. Bhat
Department of Audiology & Speech Language Pathology,
Kasturba Medical College (Unit of Manipal University),
Mangalore, Karnataka - 575 001,
India

E-mail: milimarym@gmail.com

One aspect of laryngeal function that is of great interest is the extent of vocal fold closure or adduction during phonation. This information is used for diagnostic purposes, since many of the vocal pathologies reflect abnormalities in approximation as well as in evaluating the effectiveness of a particular treatment strategy used in overcoming this abnormality.

While direct visualization using a videostroboscopy is a preferred method for judging adduction patterns, the procedure is expensive, invasive and needs specialized training. Non-invasive methods for the same include electroglottography (EGG), airflow measures, perceptual and acoustic analyses. EGG and airflow measures could prove to be expensive and with a number of biological and physiological factors governing the use of instruments. Also, perceptual analysis being subjective is not highly reliable. Of these, acoustic-based analysis has several advantages.

Modern acoustic analysis systems are relatively inexpensive and are user-friendly. They provide automatic quantitative information that can be used in both diagnosis and treatment of voice disorders. The Multi Dimensional Voice Program (MDVP) is a clinical application for the Computerized Speech Lab (CSL) by Kay Elemetrics. This program automatically extracts and displays 33 separate voice parameters that can be compared to threshold values and displayed graphically. One of the parameters is the Soft Phonation Index (SPI). According to the developers of the software, SPI is an evaluation of the weakness of the high-frequency harmonic components that may be an indication of loosely adducted vocal folds during phonation. It reflects the average ratio of low frequency (70–1600 Hz) harmonic energy to the higher frequency (1600–4500 Hz) harmonic energy for the voiced areas in the analyzed signal. Rigidity of vocal tract walls, vocal source and weaker or less complete vocal fold closure affect the resultant spectral slope [2]. Therefore, increased values of SPI are thought to indicate incomplete vocal fold adduction.

Previous research involving SPI has focused on this index as one of many potential indicators of variations in vocal quality. Munoz et al. [3] studied a group of acoustic and perceptual parameters as potential indicators of normal and pathological voices and concluded that SPI was not a significant factor for female voices but was one of several significant factors for male voices perceived as hoarse. Another study compared the EGG and acoustic signal between normals and speakers with unilateral vocal fold paralysis and cordectomy, to determine using vowel /u/ as stimulus. It was found that SPI was a better indicator of breathiness in voice than EGG [2]. Bhuta et al. noted that SPI correlated with the parameters of breathiness and aethenia from GRABS scale, in a retrospective review of 37 voice patients including male and female subjects [4]. Another study investigated the applicability of SPI as an indicator of vocal fold adduction in samples of normal, breathy

and pressed phonation produced by normal female speakers [5]. A significant increase in SPI was noted for breathy as well as pressed phonations.

From the above it can be understood that the research involving SPI is inconclusive on the clinical utility of the parameter. The literature is scarce as well as unclear. There is poor representation of subjects with diverse voice disorders that result in breathy voices due to poor or incomplete vocal fold adduction. Also the fact that female subjects could tend to have breathy voices, due to the presence of a posterior chink, and the influences of hormonal changes on voice cannot be ruled out entirely. These could have an effect on SPI readings.

Need for study

The above literature throws light on the fact that acoustic analysis is a preferred method for the diagnosis of voice disorders. In India, MDVP is a widely used program of voice analysis. Population norms and clinical utility of the parameters analyzed through this program is often not taken into consideration. This could lead to a bias and misinterpretation of the results. Thus, the possibility of an accurate diagnosis is lost. This study attempts to study SPI, one such parameter which provides information on vocal fold adduction.

Objective of the study

The study aims to determine the sensitivity of the acoustic parameter of SPI, analyzed in MDVP, as a reflective indicator of incomplete vocal fold adduction in male patients diagnosed with unilateral vocal nodules, with perceptually perceived breathy voices.

Materials and methods

This was a prospective study carried out in a multidisciplinary hospital in the southern part of India.

Participants

Seventy age-matched male participants were included in the study and divided into two groups. The participants were in the age range of 20–50 years.

The experimental group included 35 participants with unilateral vocal nodules, confirmed on laryngeal examination by a laryngeal surgeon. The control group included 35 individuals with normal vocal cord functioning. None of the participants had a history of any other speech, hearing, medical or neurologic disorders.

Instrumentation

Multi Dimensional Voice Program of CSL 4150 from Kay Elemetrics was used.

Procedure

The voice samples in the experimental group were perceptually rated as breathy voices by two experienced speech language pathologists.

Acoustic analysis was done in a sound treated room. A four second voice sample of sustained vowel /a/ was recorded directly into the CSL 4150 using a 50 Hz sampling rate and 16 bit quantization. The microphone was placed at a distance of 15 cm from the mouth. Participants were asked to phonate at their natural pitch and loudness levels. This phonation sample was subjected to analysis for obtaining the SPI values.

The readings of SPI on the MDVP analysis was extracted and subjected to statistical analysis using Independent Samples 't-test' using SPSS Version 11.

Results

Figure 1 gives the distribution of mean values of SPI readings extracted from MDVP for the control and experimental groups.

The raw data was subjected to independent samples 't-test' and the results are as shown in Table 1.

From the table, it can be understood that there is a significant difference between the mean values for SPI between

the control and experimental groups at 0.05 and 0.01 levels of significance.

Discussion

This study aimed to determine the sensitivity of SPI, a parameter analyzed on MDVP Program, as a measure of abnormal vocal fold approximation.

From the results obtained, the parameter of SPI can be implied as sensitive to abnormalities in vocal fold adduction. This is in coherence with the study done on patients with vocal fold palsy and cordectomy, wherein SPI was found to be a good indicator of breathiness [2]. Another study showed similar results though the voice disorder that the participants had was not highlighted in it [4].

An observation in this study was that the mean for the parameter of SPI for male participants in the control group was 24.87. This is different from the normative mean as specified by the developers of MDVP for adult males of western population (mean is 7.534). This highlights the importance of developing norms for the Indian population, which will help us interpret the data in an effective manner.

Also, in the readings of SPI for both experimental and control groups, there is wide range of variation in the

Table 1 Level of significance of SPI

Groups	Mean	SD	t value	p value
Control group	24.87	12.56	−2.353	0.002
Experimental group	37.00	25.27

Fig. 1 Mean SPI values across both groups

values. There are individuals from the control group who have SPI values greater than the calculated normative mean. Similarly, in the experimental group, there were few instances of SPI values being below the calculated normative mean. This finding could be the reflection of individual differences in the mechanical and physiological functioning of vocal folds or the vocal tract as a whole.

Conclusion

This study intended to ascertain the parameter of SPI from the software MDVP widely used in clinical set-ups for the understanding and diagnosis of voice disorders. A comparison was made between the means of SPI values obtained for two groups of subjects, 35 males with normal vocal fold functioning and 35 males with unilateral vocal nodules. The results on statistical analysis reveal a significant difference in the means of the groups, thus implying SPI to be a good indicator of abnormalities in vocal fold adduction. This conclusion, however, is drawn with caution keeping in mind individual differences in terms of vocal fold mechanical and physiological properties. Further, it can be suggested that more studies are required with control over the variables

mentioned. Also one can arrive at a comprehensive picture by including more number of participants and considering more vocal pathologies. In general, this study substantiates the need for establishing the sensitiveness of the parameters available in software's used in assessment process of disordered populations and for developing normative values for Indian population.

References

1. Boone D (2005) The normal voice. In: Boone D, Mc Farlane SC and Von Berg SL (eds) *The voice and voice therapy*, 7th edn. Boston: Pearson Education Inc., pp 15–42
2. Koreman J and Putzer M (1997) Finding correlates of vocal fold adduction deficiencies. *Phonus* 3:155–178
3. Munoz J, Mendoza E, Fresneda MB, Carballo G and Lopez P (2003) Acoustic and perceptual indicators of normal and pathological voice. *Folia Phoniatria et Logopaedia* 55:102–114
4. Bhuta T, Patrick L and Garnett JD (2003) Perceptual evaluation of voice quality and its correlation with acoustic measurements. *J Voice* 18 (3):299–304
5. Roussel NC and Lobdell M (2006) The clinical utility of the soft phonation index. *Clin Linguistics Phonetics* 20(2): 181–186